

Environmental protection in chemical technology - laboratory**MICELLAR ENHANCED ULTRAFILTRATION IN WATER TREATMENT PROCESSES**

Prepared by Joanna Wolska

Introduction

Nowadays, one serious problem with a high impact on the environment and human health is the contamination of water with toxic or carcinogenic heavy metal ions. Because of the fact that these ions are small in size they are removed by adsorption rather than by filtration processes. Some adsorbers are, e. g. carbon based materials like activated carbon or carbon nanotubes, zeolites or bio-based materials like chitosan or lignin. If ionic surfactants are added to water with concentrations higher than the critical micelle concentration (cmc), the heavy metal ions can adsorb at the charged surface of the micelles in form of metal complexes. These aggregates are large enough to be filtered with an appropriate ultrafiltration membrane so that efficient heavy metal removal is now possible for applying the technique of micellar enhanced ultrafiltration (MEUF) [1]. MEUF has been used for the removal of inorganic, organic and nutrients such as nitrate and phosphate [2]. For cation removal an often used anionic surfactant is sodium dodecylsulfate (SDS), which allows for efficient removal of, e.g. Cu^{2+} , Cd^{2+} , Ni^{2+} , Pb^{2+} [1]. For anion (e. g. Pentavalent form of arsenic, or hexavalent chromium) removal a cationic surfactant is used e. g. hexadecylpyridinium chloride (CPC), hexadecyltrimethylammonium bromide (CTAB) [2,3].

During the study the polysulfone asymmetric ultrafiltration membrane from will be used. The influence of the concentration of surfactant and the concentration of chromium VI will be investigated on the efficiency of the MEUF process.

Materials

potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) from POCh
surfactant Cetrimonium bromide CTAB from Fluka

Experimental**1. Measurement of the water flux**

- Put a membrane to the Amicon dead-cell (skin side up),
- Fill the apparatus with the 100 mL of distilled water,
- Turn on the compressor, regulating monostat pressure of 0.1 MPa,
- Measure the flow time of three 10 mL of portions of water,
- Turn the monostat and compressor off, pour the water from the cell without removing of membrane from the apparatus.

2. Measurement of the rejection coefficient in removing chromium VI

- Fill the apparatus with the 100 mL of solution of surfactant and chromium VI (the concentration of surfactant and Cr(VI) will be given during exercise),

- b. Turn on the compressor, regulating monostat pressure of 0.1 MPa,
- c. Measure the flow time of one 10 mL portion of filtrate,
- d. Checked the concentration of chromium in this permeate spectrophotometer UV/VIS (calibration curve),
- e. Measure the flow time of the next 10 mL portion of filtrate,
- f. Checked the concentration of chromium in this permeate spectrophotometer UV/VIS (calibration curve),
- g. Measure the flow time of the next 10 mL portion of filtrate,
- h. Checked the concentration of chromium in this permeate spectrophotometer UV/VIS (calibration curve),
- i. Measure the flow time of the next 10 mL portion of filtrate,
- j. Checked the concentration of chromium in this permeate spectrophotometer UV/VIS (calibration curve),
- k. Measure the flow time of the next 10 mL portion of filtrate,
- l. Checked the concentration of chromium in this permeate spectrophotometer UV/VIS (calibration curve),
- m. Turn the monostat and compressor off, pour the solution from the cell without removing of membrane from the apparatus,
- n. Fill the apparatus with the next 100 mL of solution of surfactant and chromium VI
Fill the apparatus with the 100 mL of solution of surfactant and chromium VI (the concentration of surfactant and Cr(VI) will be given during exercise),
- o. Turn on the compressor, regulating monostat pressure of 0.1 MPa,
- p. Measure the flow time of five 10 mL portion of filtrate, after every portion checked the concentration of chromium VI in the permeate using the spectrophotometer UV/VIS (calibration curve) as in the case of first type of solution,
- q. Turn the monostat and compressor off, pour the solution from the cell,
- r. Remove the membrane and measure the active surface,
- s. Prepare the calibration curve for chromium VI.

3. Measurement of the water flux after MEUF process

- a. Fill the apparatus with the 50 mL of distilled water,
- b. Turn on the compressor, regulating monostat pressure of 0.1 MPa,
- c. Measure the flow time of one 10 mL of portions of water,
- d. Turn the monostat and compressor off,
- e. Remove the membrane and measure the active surface.

Calculations

1. Permeation flux (J):

$$J = \frac{V}{S \times t} \left[\frac{\text{cm}^3}{\text{cm}^2 \text{s}} \right], \quad (1),$$

where:

V – volume of filtrate, cm^3 ,

S – active surface of membrane, cm^2 ,

t – measurement time, s.

2. The rejection coefficient (R):

$$R = (1 - \frac{c_p}{c_o}) \cdot 100\%, \quad (2),$$

where:

c_o – the initial concentration of chromium VI, g/L,

c_p – the concentration of chromium VI in permeate, g/L.

plot the graph

[1] M. Schwarze, M. Groß, M. Moritz, G. Buchner, L. Kapitzki, L. Chiappisi, M. Gradzielski, *J. Membr. Sci.*, 478 (2015) 140-147.

[2] J. Iqbal, H.-J. Kim, J.-S. Yang, K. Baek, J.-W. Yang, *Chemosphere*, 66(5) (2007) 970-976.

[3] G. Ghosh, P. K. Bhattacharya, *Chem. Engineer. J.*, 119(1) (2006) 45-53.

Attention

The report should contain:

- 1. The object of exercises,**
- 2. Short introduction,**
- 3. The measurements results in the tables,**
- 4. All calculations,**
- 5. Conclusions**